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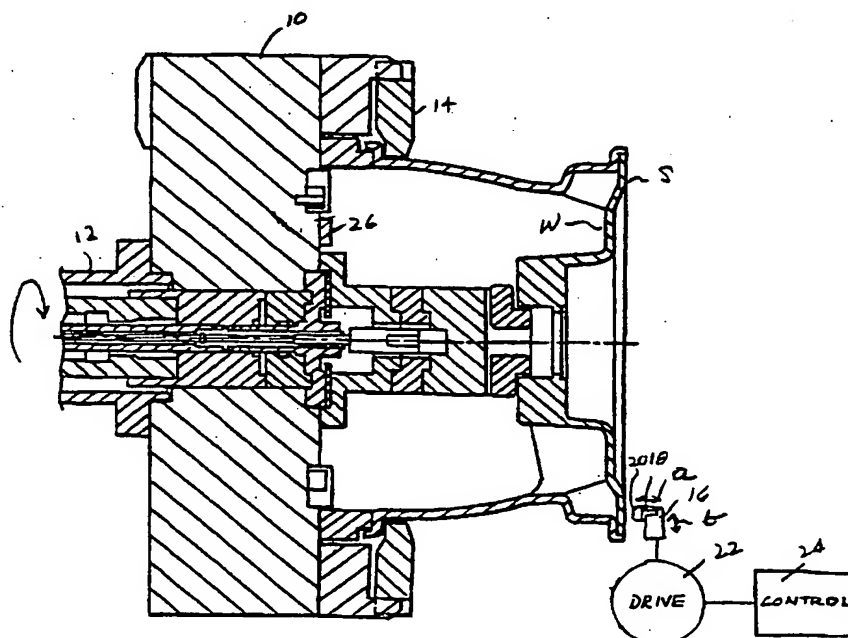
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(54) Title: MIRROR SURFACE FINISHING



(57) Abstract: A method of finishing a metal and a vehicle wheel or wheel cover which is finished by the method and which has a surface roughness of less than about 3.2 μ Z comprises machining the surface with a natural single crystal diamond tool.



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MIRROR SURFACE FINISHING

BACKGROUND AND SUMMARY OF INVENTION

The present invention is directed to the surface finishing of a metal and, more specifically, to the finishing of cast aluminum surfaces to produce a high quality mirror surface, such as for automobile wheels and covers.

Aluminum wheels and wheel covers of various designs have been used to dress up automobile wheels. Some have their decorative surfaces painted, or they may be partially or completely machined to produce contrasting appearances. Other wheels or covers feature shiny, mirror surface finishes which in the past have been obtained by buffing or electroplating. However, both of these finishing procedures suffer disadvantages. Buffing frequently results in a dull surface, especially at the edge of the decorative surface, and does not produce the sharp looking and highly mirrored finish that is desirable. Electroplating does produce an excellent mirror surface finish, but at high cost and with undesirable environmental impact.

It is the purpose of the present invention to utilize a machining technology which is of relatively low cost, which does not experience negative environmental impact, and which consistently produces an excellent, highly reflective, mirror surface finish. The machining technologies which have been employed in the past have not been able to achieve some or all of these goals. It is also a purpose of the present invention to produce highly mirrored, machined surfaces which are capable of receiving a clear transparent coating which

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protects against oxidation of the surface, and yet displays the highly decorative machined surface.

The quality of a highly reflective, mirror surface is dependent upon the level of surface roughness of the surface following finishing or machining. In the machining technologies which have been employed in the past and which have relied upon the use of synthetic multicrystal diamond cutting tools, surface roughness levels of between about $3.2\text{-}20\mu\text{Z}$ have only been realized. However, in the present invention, cast aluminum surfaces can be surface finished to surface roughness levels of less than $3.2\mu\text{Z}$, preferably to about $1.0\mu\text{Z}$ or less, and even more preferably to levels as low as $0.3\mu\text{Z}$.

These high quality, highly mirrored, very low surface roughness finishes are obtained in the present invention with a cutting tool of a natural, single crystal diamond. Such natural, single crystal diamonds are much harder than the hardness of the artificial diamond cutting tools which have been employed in the past, and the natural diamonds have been found to produce the much lower, more desirable surface roughness levels of the present invention, i.e., roughness levels of $1.0\mu\text{Z}$ to as little as $0.3\mu\text{Z}$ as contrasted to the prior levels of $3.2\mu\text{Z}$ or more.

Accordingly, in one principal aspect of the present invention, a method of finishing a metal to produce a highly mirrored surface having a surface roughness of less than about $3.2\mu\text{Z}$, comprises machining the surface with a natural single crystal diamond tool.

In another principal aspect of the present invention, the metal is aluminum.

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In still another principal aspect of the present invention, the surface roughness does not exceed about $1.0\mu Z$, and is preferably between about 0.3 and $1.0\mu Z$.

In still another principal aspect of the present invention, the highly mirrored surface is the surface of a vehicle wheel or wheel cover.

In still another principal aspect of the present invention, at least one coating is applied to the machined highly mirrored surface.

In still another principal aspect of the present invention, the coating is a leveling primer and/or a transparent top coat.

In still another principal aspect of the present invention, a vehicle wheel or wheel cover has a highly mirrored machined metal surface with a surface roughness of less than about $3.2\mu Z$.

In still another principal aspect of the present invention, the surface roughness of the wheel or wheel cover does not exceed about $1.0\mu Z$, and is preferably between about 0.3 to $1.0\mu Z$.

In still another principal aspect of the present invention, the metal of the wheel or wheel cover is aluminum.

These and other objects, features and advantages of the present invention will be more clearly understood through a consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWING

In the course of this description, reference will frequently be made to the attached drawing in which the sole figure is a schematic cross-sectioned side elevational view of a chuck for holding and rotating a wheel or wheel cover for surface finishing in accordance with the invention, a tool

holder for the single diamond cutting tool and a control and drive assembly therefor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the preferred embodiment of the invention as shown in the drawing, a rotating chuck 10 is mounted for rotation by a drive shaft 12, both of which are mounted on a conventional turning machine bed (not shown). The chuck 10 includes clamps 14 for holding the wheel or wheel covers W, the surface S of which is to be mirror finished in accordance with the invention.

A tool holder 16 holds a cutting tool 18 which carries a natural single crystal diamond 20 of the invention. A suitable drive 22 is provided to drive the tool holder with its diamond 20 both in the direction of the arrow a shown in the drawing toward and away from the surface S to be finished, and the arrow b across the surface S being finished. The drive 22, tool holder 16 and diamond 20 is controlled by a suitable conventional control 24, such as a numerical control.

In order to insure that surface roughness level variations are minimized in the present invention, the rotating chuck 10 is preferably dynamically balanced by balance weights 26 as needed. In addition, plastic plates may be patched to the bed of the machine to absorb machine vibration itself, and the machine is preferably isolated from the ground with natural rubber plates placed between the machine legs and the floor.

Although not to be taken as limiting, the following cutting conditions are given by way of example:

Rotation speed of chuck: 1500 rpm

Feed rate of diamond cutting tool: 0.02mm/rev

Cutting depth: 0.04mm

Diamond tool nose radius: 2R.

The highly mirrored, machined surfaces of the present invention are preferably covered with a top clear coat, as is conventional in the wheel or wheel cover art. These clear coats are typically applied to the surface in a thickness of less than 40μ , and may comprise any number of known spray paints, such as lacquers or epoxy coatings. Leveling primers as known in the art may also be optionally employed to coat the machined surface before the application of the clear top coat. Such leveling primers are also well known to those in the art.

Examples

Several samples of cast aluminum were surface finished to produce differing degrees of surface roughness of from $3.2\mu Z$ to $0.3\mu Z$. Each of these finished surfaces was coated with a leveling primer coat of a thickness of $3-10\mu$ followed by a top clear coat of a thickness of $20-30\mu$. The sample having the $3.2\mu Z$ surface roughness was obtained using conventional machining techniques and a synthetic diamond cutting tool, while the remaining samples of the more desirable, lower surface roughness were obtained utilizing the natural single crystal diamond cutting tool of the present invention. In the example which was finished using the conventional technology, the surface roughness even after coating with the leveling primer and a clear top coat, had a smoothness of the clear top coat surface which was inferior to the other examples.

The surface roughness was measured with conventional roughness measurement equipment of the type which employs a needle which moves laterally across the surface to be measured and the needle movements are amplified and recorded.

The sharpness of appearance of each of the samples was also tested with a memory ruler of the kind which is typically utilized by those in the art for the measurement of surface roughness. Generally, this procedure places a ruler with a scale on the machined surface with a tilt. The longest distance of the legible scale reflected is used for evaluation.

The results of these tests are set forth in the following table.

Example	Surface Roughness, μZ		Sharpness of Appearance
	Machined Surface	After Clear Coat	
A	0.3	0.08	Excellent
B	0.8	0.15	Good
C	1.1	0.18	Fair
D	3.2	0.80	Poor

It will be understood that the preferred embodiment of the present invention which has been described is merely illustrative of the principles of the present invention. Modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention.

I Claim:

1. A method of finishing a metal to produce a highly mirrored surface having a surface roughness of less than about $3.2\mu\text{Z}$, comprising machining the surface with a natural single crystal diamond tool.
2. The method of claim 1, wherein said metal is aluminum.
3. The method of claim 1, wherein said surface roughness does not exceed about $1.0\mu\text{Z}$.
4. The method of claim 1, wherein said surface roughness is between about 0.3 and $1.0\mu\text{Z}$.
5. The method of claim 2, wherein said surface roughness is between about 0.3 and $1.0\mu\text{Z}$.
6. The method of claim 1, wherein said highly mirrored surface is the surface of a vehicle wheel or wheel cover.
7. The method of claim 1, including applying at least one coating to said machined highly mirrored surface.
8. The method of claim 7, wherein said coating is a leveling primer and/or a transparent top coat.
9. The method of claim 2, including applying at least one coating to said machined highly mirrored surface.

10. The method of claim 9, wherein said coating is a leveling primer and/or a transparent top coat.

11. The method of claim 5, including applying at least one coating to said machined highly mirrored surface.

12. The method of claim 11, wherein said coating is a leveling primer and/or a transparent top coat.

13. A vehicle wheel or wheel cover having a highly mirrored machined metal surface with a surface roughness of less than about $3.2\mu\text{Z}$.

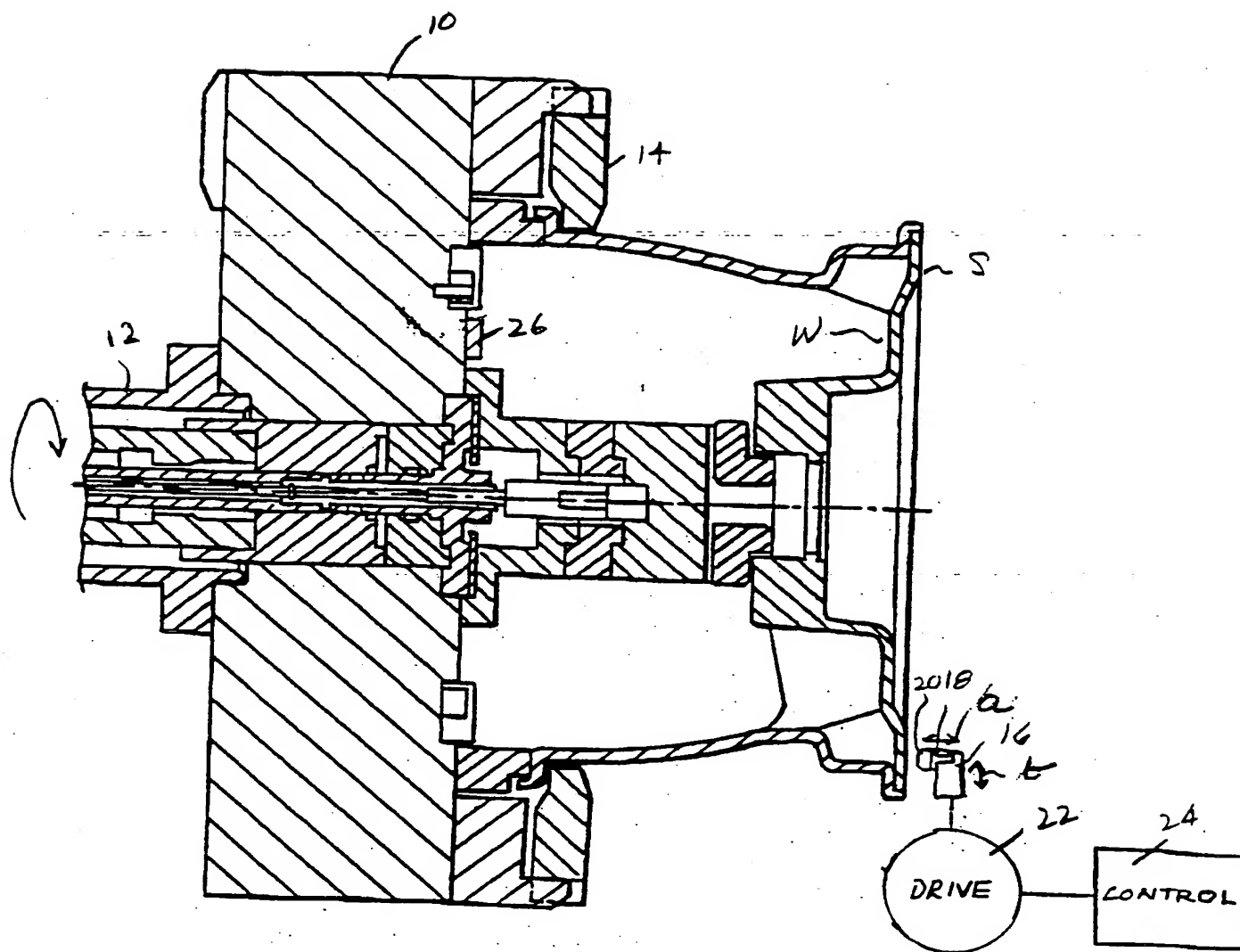
14. The vehicle wheel or wheel cover of claim 13, wherein said surface roughness does not exceed about $1.0\mu\text{Z}$.

15. The vehicle wheel or wheel cover of claim 13, wherein said surface roughness is between about 0.3 and $1.0\mu\text{Z}$.

16. The vehicle wheel or wheel cover of claim 13, wherein said metal is aluminum.

17. The vehicle wheel or wheel cover of claim 16, wherein said surface roughness does not exceed about $1.0\mu\text{Z}$.

18. The vehicle wheel or wheel cover of claim 16, wherein said surface roughness is between about 0.3 and $1.0\mu\text{Z}$.



INTERNATIONAL SEARCH REPORT

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PCT/IB 00/01644

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B23B27/20 B23B5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 022 797 A (SAWA) 11 June 1991 (1991-06-11)	1-5
A	column 1, line 8 - line 11 column 4, line 14 - line 22	6,13-18
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 397 (M-1452), 26 March 1993 (1993-03-26) & JP 05 077601 A (WASHI KOSAN), 30 March 1993 (1993-03-30) abstract	8-12
X	EP 0 418 959 A (PHILIPS) 27 March 1991 (1991-03-27) page 2, line 1 - line 15	1-5

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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>GB 282 596 A (POULAIN) 29 December 1927 (1927-12-29) page 1, line 8 - line 11</p>	

INTERNATIONAL SEARCH REPORT

Information on patent family members

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